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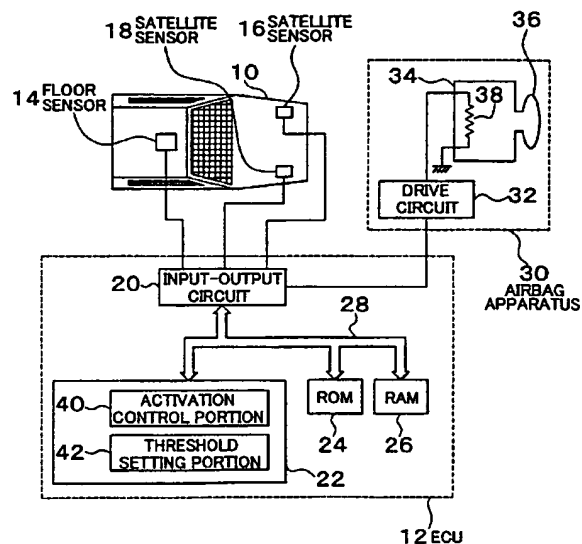
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(54) Title: APPARATUS AND METHOD FOR CONTROLLING AN AIRBAG DEPLOYMENT

(57) Abstract: Satellite sensors (16, 18) that output level signals corresponding to an impact on a vehicle (10) are provided right and left portions of a forward portion of the vehicle (10), separately from a floor sensor (14). If a map (Lo1, Lo2, Lo3, Hi) selected as a threshold changing pattern from an impact (deceleration) detected based on the output signal of one of the satellite sensors (16, 18) and a map (Lo1, Lo2, Lo2, Hi) selected as a threshold changing pattern from an impact (deceleration) detected based on the output signal of the other satellite sensor are different from each other, the map of a smaller threshold is selected from the maps based on the output signals of the two satellite sensors (16, 18), and is set as a threshold changing pattern for determining whether to activate an airbag apparatus (30).

APPARATUS AND METHOD FOR CONTROLLING AN AIRBAG DEPLOYMENT

BACKGROUND OF THE INVENTION

5   1. Field of the Invention

The invention relates to an activation control

apparatus and an activation control method thereof to be

used to control the activation of an airbag apparatus and,

more particularly, to an airbag apparatus activation

10   control apparatus that is suitable in properly activating

an airbag apparatus for protecting an occupant at the time

of a collision of a vehicle.

2. Description of the Related Art

15   An activation control apparatus of an airbag

apparatus is conventionally known as disclosed in, for

example, Japanese Patent Application Laid-Open No. 11-

286257, which has a floor sensor that is disposed on a

floor tunnel of a vehicle body and that outputs a signal

20   corresponding to the impact that occurs on the floor

tunnel, and which deploys an airbag when the value of a

parameter based on the output signal of the floor sensor

exceeds a threshold. This apparatus further has a

satellite sensor that is disposed in a forward portion of

25   the vehicle body and that outputs a signal corresponding to

the impact received by the forward portion of the vehicle

body. The apparatus increases the amount of reduction of

the aforementioned threshold with increases in the impact

received by the forward portion of the vehicle body that is

detected based on the output signal of the satellite

sensor. Therefore, the airbag deploys more easily if the

5   impact that occurs on the forward portion of the vehicle

body is greater. Thus, according to the above-described

conventional apparatus, the airbag apparatus for protecting

an occupant can be appropriately activated.

In the case of an offset collision or the like, the

10   impacts received by right and left forward portions of the

vehicle body are greatly different from each other. In the

aforementioned conventional apparatus, satellite sensors

are provided in right and left forward portions of the

vehicle body. Therefore, if a vehicle having an

15   arrangement as described above undergoes an offset

collision, the satellite sensors output signals different

from each other. Therefore, in a construction having a

plurality of satellite sensors as described above, there is

a need to process different signals outputted from

20   different satellite sensors.

SUMMARY OF THE INVENTION

The invention has been accomplished in view of the

aforementioned considerations. It is an object of the

25   invention to provide an airbag apparatus activation control

apparatus and an airbag activation control method capable

of setting a threshold for activation of an airbag

apparatus to a proper value if different output signals are received from a plurality of sensors disposed in various portions of a vehicle.

5   The aforementioned object may be achieved, for example, by an airbag apparatus activation control apparatus comprising a first sensor that is disposed at a predetermined position in a vehicle and that outputs a signal corresponding to an impact that occurs on the vehicle, and activation control means for activating an

10   airbag apparatus if a parameter value f(Gf) based on the signal outputted by the first sensor exceeds a predetermined threshold (SH), a plurality of second sensors each of which is disposed at a position in the vehicle that is different from a position of the first sensor and each

15   of which outputs a signal corresponding to an impact that occurs on a site in the vehicle related to the sensor; wherein the airbag apparatus activation control apparatus further comprises threshold changing means for changing the predetermined threshold (SH) in accordance with signals

20   outputted by the plurality of said second sensors on the basis of a threshold reduction map.

The aforementioned object may further be achieved, for example, by an airbag apparatus activation control method

25   for activating an airbag apparatus if a parameter value f(Gf) based on a signal corresponding to an impact that occurs on a vehicle exceeds a predetermined threshold (SH),

wherein the method comprises the steps of: setting a

threshold (SH);   detecting an impact that occurs on the

vehicle via a first sensor, and setting a parameter value

f(Gf) based on a signal outputted by the first sensor in

5   accordance with the impact; detecting an impact that occurs

on the vehicle via a plurality of second sensors that are

disposed at positions in the vehicle different from a

position of the first sensor, and changing the

predetermined threshold (SH) in accordance with signals

10   outputted by the plurality of said second sensors on the.

basis of a threshold reduction map; and activating the

airbag apparatus if the parameter value f(Gf) exceeds the

threshold (SH).

15   According to a further aspect of the invention, the

threshold (SH) is changed in accordance with a signal that

indicates a greatest impact among signals outputted by the

plurality of said second sensors.

20   According to a further aspect of the invention, if at least

one of the plurality of second sensors has a failure, the

threshold (SH) is changed in accordance with the signal

outputted by at least one second sensor that does not have

a failure.

25

According to a still further aspect of the invention, a

failsafe predetermined value is set, if at least one of the

plurality of second sensors has a failure, and the

predetermined threshold (SH) is set to the failsafe

predetermined value when the predetermined threshold (SH)

based on the signal from the at least one second sensor

5   that does not have a failure is greater than the failsafe

predetermined value.

According to a further aspect of the invention, a value

outputted by the second sensors is a deceleration of the

10   vehicle or a value obtained by integrating the deceleration

with respect to a unit time.

According to a further aspect of the invention, the

plurality of second sensors are disposed forward of the

15   first sensor within the vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features, advantages,

and technical and industrial significance of this invention

20   will be better understood by reading the following detailed

description of exemplary embodiments of the invention, when

considered in connection with the accompanying drawings, in

which:

FIG. 1 is a diagram illustrating a system

25   construction of a input-output circuit 20 of an activation

control apparatus of an airbag apparatus in accordance with

an embodiment of the invention;

FIG. 2 is a diagram in which a relationship between the calculated value f(Gf) and the speed Vn under a predetermined circumstance is plotted at every predetermined time;

5   FIG. 3 is a diagram indicating changing patterns of a threshold SH that functions as a determination map for the relationship between the calculated value f(Gf) and the speed Vn in this embodiment;

FIG. 4 is a diagram for illustrating a technique for 10   setting a changing pattern of the threshold SH in this embodiment.;

FIG. 5 is a map for setting a threshold changing pattern for activation of the airbag apparatus based on a relationship between the threshold changing patterns that 15   are to be set based on the output signals of two satellite sensors; and

FIG. 6 is a flowchart illustrating a control routine executed in this embodiment.

20   DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following description and the accompanying drawings, the present invention will be described in more detail in terms of preferred embodiments.

FIG. 1 is a diagram illustrating a system 25   construction of an activation control apparatus of an airbag apparatus in accordance with an embodiment of the invention. A system in this embodiment includes an

electronic control unit (hereinafter, referred to as "ECU")
12 installed in a vehicle 10, and is controlled by the ECU
12.

The system of this embodiment includes a floor sensor
14 disposed near a floor tunnel extending in a central
portion of a vehicle body, and satellite sensors 16, 18
disposed in left and right side members disposed in a
forward portion of the vehicle body. Each of the floor
sensor 14 and the satellite sensors 16, 18 is an electronic
deceleration sensor that outputs a signal corresponding to
the magnitude impact that occurs on the site where the
sensor is disposed and, more specifically, a signal
corresponding to the magnitude of deceleration in a fore-
aft direction of the vehicle (hereinafter, referred to as
"level signal"). Furthermore, each of the floor sensor 14
and the satellite sensors 16, 18 has a self-diagnostic
function, and outputs a signal that indicates whether the
sensor functions normally or has a failure (hereinafter,
referred to as "normality/failure discrimination signal)
together with the level signal to the outside at every
predetermined period.

The ECU 12 is formed by an input-output circuit 20, a
central processing unit (hereinafter, referred to as "CPU")
22, a read-only memory (hereinafter, referred to as "ROM")
24 in which processing programs and tables needed for
calculations are pre-stored, a random access memory
(hereinafter, referred to as "RAM") 26 for use as work

areas, and a bidirectional bus 28 that connects these
component elements.

The floor sensor 14 and the satellite sensors 16, 18
are connected to the input-output circuit 20 of the ECU 12.
5   The output signals of the floor sensor 14 and the satellite
sensors 16, 18 are separately supplied to the input-output
circuit 20, and are suitably stored in the RAM in
accordance with instructions from the CPU 22. The ECU 12
detects the magnitude Gf of deceleration that occurs on a
10   central portion of the vehicle body based on the output
signal of the floor sensor 14, and also detects the
magnitudes G_{SL}, G_{SR} of deceleration that occur on left and
right forward portions of the vehicle body based on the
output signals of the satellite sensors 16, 18. The ECU 12
15   determines whether any one of the sensors has a failure
based on the normality/failure discrimination signal
outputted from each sensor in accordance with a result of
self-diagnosis.

The system of this embodiment further includes an
20   airbag apparatus 30 that is installed in the vehicle 10 and
that is operated so as to protect an occupant. The airbag
apparatus 30 has a drive circuit 32, an inflator 34, and an
airbag 36. The inflator 34 contains therein an igniter
device 38 connected to the drive circuit 32, and a gas-
25   producing agent (not shown) that produces a large amount of
gas by using heat generated by the igniter device 38. The
airbag 36 is inflated and deployed by the gas produced.

The airbag 36 is disposed at a position such that when

inflated and deployed, the airbag 36 comes into a space

between an occupant in the vehicle 10 and component parts

installed in the vehicle.

5   The drive circuit 32 of the airbag apparatus 30 is

connected to the input-output circuit 20 of the ECU 12.

The airbag apparatus 30 is activated to deploy the airbag

36 when a drive signal is supplied to the drive circuit 32

from the input-output circuit 20. The CPU 22 of the ECU 12

10 has an activation control portion 40 and a threshold

setting portion 42. The activation control portion 40 of

the CPU 22 calculates a predetermined parameter based on

the deceleration Gf detected through the use of the output

signal of the floor sensor 14 as described below in

15 accordance with a processing program stored in the ROM 24,

and determines whether the value of the parameter

calculated exceeds a predetermined threshold SH.

Furthermore, the activation control portion 40 controls the

supply of the drive signal from the input-output circuit 20

20 to the drive circuit 32 of the airbag apparatus 30 based on

a result of the determination. The threshold setting

portion 42 appropriately sets the predetermined threshold

SH for use in the activation control portion 40 based on

the decelerations G_{SL}, G_{SR} detected based on the output

25 signals of the satellite sensors 16, 18.

The next described will be a content of processing

executed by the CPU 22 in this embodiment. In this

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embodiment, the activation control portion 40 determines a

calculated value f(Gf) and a speed Vn through predetermined

calculation with the deceleration Gf detected based on the

output signal of the floor sensor 14. More specifically,

5   the speed Vn is a value obtained by time integration of the

deceleration Gf. That is, if a deceleration Gf is applied

to the vehicle 10 while the vehicle 10 is running, a mass

in the vehicle (e.g., an occupant) accelerates forward

relative to the vehicle 10 due to inertia. In such a case,

10   therefore, the speed Vn of the mass present in the vehicle

relative to the vehicle 10 can be determined through time

integration of the deceleration Gf. The calculated value

f(Gf) may be the deceleration Gf itself, or may also be a

value obtained through time integration of the deceleration

15   Gf with respect to unit time. FIG. 2 shows a diagram in

which a relationship between the calculated value f(Gf) and

the speed Vn under a predetermined circumstance is plotted

at every predetermined time. After determining the

calculated value f(Gf) and the speed Vn, the activation

20   control portion 40 compares the magnitude of a value

determined from the relationship between the calculated

value f(Gf) and the speed Vn as indicated in FIG. 2 with

the magnitude of the threshold SH, which has been set as a

determination map by the threshold setting portion 42.

25   FIG. 3 shows a diagram indicating changing patterns

of the threshold SH (hereinafter, referred to as "threshold

changing patterns") that functions as a determination map

for the relationship between the calculated value f(Gf) and

the speed Vn in this embodiment. FIG. 3 indicates five

threshold changing patterns, that is, a Hi map, a Lo3 map,

a Lo2 map, a Lo1 map, and a failsafe map. In this

5   embodiment, the Hi map is a map that serves as a reference,

and the failsafe map partially overlaps the Lo3 map. FIG.

4 shows a diagram for illustrating a technique for setting

a threshold changing pattern in this embodiment.

In this embodiment, the threshold setting portion 42

10   stores threshold changing patterns with regard to the

relationship between the calculated value f(Gf) and the

speed Vn that are empirically determined beforehand as

indicated in FIG. 3. These threshold changing patterns are

set on boundaries between a case where the airbag apparatus

15   30 needs to be activated upon an impact on the vehicle 10

and a case where there is no such need on the basis of the

decelerations G_{SL}, G_{SR} based on the output signals of the

satellite sensors 16, 18.

That is, if the impact given to a forward portion of

20   the vehicle body is greater, the possibility of collision

of the vehicle 10 is higher, so that it is appropriate to

change threshold changing patterns so that the airbag

apparatus 30 is more prone to be activated. In this

embodiment, therefore, the threshold setting portion 42

25   selects and sets a threshold changing pattern in such a

fashion that the threshold SH is reduced if the

decelerations G_{SL}, G_{SR} detected based on the output signals

of the satellite sensors 16, 18 are greater. More

specifically, if the decelerations G_{SL}, G_{SR} are less than a

first predetermined value G_{S1}, the Hi map is selected as a

threshold changing pattern as indicated in FIG. 4. If the

5   decelerations G_{SL}, G_{SR} are equal to or greater than

predetermined value G_{S1} but are less than a predetermined

value G_{S2}, the Lo3 map is selected. If the decelerations

G_{SL}, G_{SR} are equal to or greater than the second

predetermined value G_{S2} but are less than a third

10   predetermined value G_{S3}, the Lo2 map is selected. If the

decelerations G_{SL}, G_{SR} are equal to or greater than the

third predetermined value G_{S3}, the Lo1 map is selected. If

a failure occurs in the satellite sensor 16, 18 or an

abnormality occurs in communication between the satellite

15   sensors 16, 18 and the ECU 12, the failsafe map is

selected.

In the above-described construction, the activation

control portion 40 supplies the drive signal from the

input-output circuit 20 to the drive circuit 32 of the

20   airbag apparatus 30 if comparison of the value determined

from the relationship between the calculated value f(Gf)

and the speed Vn with the threshold SH of the threshold

changing pattern selected and set by the threshold setting

portion 42 shows that the value determined from the

25   relationship between the calculated value f(Gf) and the

speed Vn is greater than the threshold SH. In this case,

the airbag apparatus 30 is activated so as to deploy the

12

airbag 36.

Thus, according to this embodiment, the threshold for activating the airbag apparatus 30 is changed in accordance with the impact given to on a forward portion of the vehicle body. Therefore, it is possible to execute a suitable control of the activation of the airbag apparatus 30 in accordance with the fashion of collision of the vehicle 10, such as a head-on collision, an offset collision, a diagonal collision, etc. Hence, the airbag apparatus 30 is more readily activated if a greater impact occurs on a forward portion of the vehicle body. Thus, the airbag apparatus 30 can be properly activated.

However, in the case of an offset collision, a diagonal collision or the like, the impacts received by left and right front portions of the vehicle body are greatly different from each other. In this embodiment, the satellite sensors 16, 18 are disposed on the left and right forward portions of the vehicle body as mentioned above. Therefore, if an offset collision or the like occurs in this embodiment, the satellite sensors 16, 18 produce output signals different from each other, so that a situation may be brought about in which the map selected as a threshold changing pattern through the use of the output signal of the satellite sensor 16 and the map selected as a threshold changing pattern through the use of the output signal of the satellite sensor 18 are different. Hence, in a construction having a plurality of satellite sensors 16,

18 in a forward portions of the body vehicle as in this

embodiment, it is necessary to determine which one of the

output signals of the satellite sensors 16, 18 should be

used as a basis for changing the threshold changing pattern

5   for activation of the airbag apparatus 30.

The system of this embodiment is characterized in

that if the maps based on the output signals of the

satellite sensors 16, 18 are different from each other, one

of the output signals of the satellite sensors 16, 18 that

10   indicates a greater impact is selected as a basis for

changing the threshold changing pattern for activation of

the airbag apparatus 30, that is, of the maps based on the

output signals of the satellite sensors 16, 18, the map on

the Lo1 map side is selected as a threshold changing

15   pattern for activation of the airbag apparatus 30.

If one of the satellite sensors 16, 18 has a failure,

it is impossible to set a threshold changing pattern by

using the output signal of the failed sensor. In this

case, however, the other sensor functions normally, so that

20   a threshold changing pattern can be set by using the output

signal of the normal sensor. Therefore, in order properly

activate the airbag apparatus 30 under such a circumstance,

it is appropriate to change the threshold changing pattern

for activation of the airbag apparatus 30 based on the

25   output signal of the sensor that does not have a failure.

Hence, the system of the embodiment is characterized in

that if one of the satellite sensors 16, 18 has a failure,

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the output signal of the sensor that normally functions is used to set a threshold changing pattern for activation of the airbag apparatus 30.

In this construction, however, if under a

5   circumstance that one of the satellite sensors 16, 18 has a failure, a site of installation of the one of the satellite sensors 16, 18 that normally functions receives substantially no impact, the Hi map will be selected and set as a threshold changing pattern for activation of the

10   airbag apparatus 30. The threshold changing pattern realized in that case is a threshold changing pattern that makes the airbag apparatus 30 least prone to be activated. Therefore, the airbag apparatus 30 does not become prone to be activated, even if a great impact occurs on the site of

15   installation of the failed one of the satellite sensors 16, 18. Thus, an event that the airbag 36 is not properly deployed can occur.

If the ECU 12 detects a failure of either one of the satellite sensors 16, 18, the ECU 12 selects the failsafe

20   map as a threshold changing pattern for the failed sensor. As mentioned above, the failsafe map partially overlaps the Lo3 map, which has a smaller threshold SH than the Hi map. Therefore, if one of the satellite sensors 16, 18 has a failure and the Hi map is selected and set as a threshold

25   changing pattern by using the output signal of the sensor that normally functions, the selection of the failsafe map as a threshold changing pattern is more appropriate in view

of proper deployment of the airbag 36. Therefore, the

system of this embodiment is also characterized in that if

one of the satellite sensors 16, 18 has a failure and the

Hi map is selected and set by using the output signal of

5   the sensor that normally functions, the failsafe map is

selected and set as a threshold changing pattern for

activation of the airbag apparatus 30.

Characteristic portions of the embodiment will be

described hereinafter with reference to FIGS. 5 and 6.

10   FIG. 5 indicates a map for setting a threshold changing

pattern for activation of the airbag apparatus 30 based on

a relationship between a map that is to be set based on the

output signal of the satellite sensor 16 and a map that is

to be set based on the output signal of the satellite

15   sensor 18.

As shown in FIG. 5, if the map based on the output

signal of the satellite sensor 16 disposed on the left side

of a forward portion of the vehicle body is the same as the

map based on the output signal of the satellite sensor 18

20   disposed on the right side of the forward portion of the

vehicle body, the map is selected and set as a threshold

changing pattern for activation of the airbag apparatus 30.

Conversely, if the two maps are different from each other,

the map of a smaller threshold SH is selected and set as a

25   threshold changing pattern for activation of the airbag

apparatus 30.

In this case, the map of a greater threshold SH, of

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the maps based on the satellite sensors 16, 18, is not set

as a threshold changing pattern. Therefore, according to

the embodiment, it is possible to avoid an event that the

airbag apparatus 30 becomes less prone to be activated

5   under a circumstance that there is a great impact on one of

the right and left portions of the forward portion of the

vehicle body. Hence, the embodiment reliably avoids an

event that the airbag 36 is not deployed although there is

a great impact on one of the right and left portions of the

10   forward portion of the vehicle body, and makes it possible

to properly activate the airbag apparatus 30.

Furthermore, if, under a circumstance that the

failsafe map is selected due to a failure of one of the

satellite sensors 16, 18, the map based on the output

15   signal of the sensor that functions normally is one of the

Lo1, Lo2 and Lo3 maps (hereinafter, these maps may be

collectively termed "Lo map"), the Lo map is selected and

set as a threshold changing pattern for activation of the

airbag apparatus 30. Conversely, if under the

20   aforementioned circumstance, the map based on the output

signal of the sensor that normally functions is the Hi map,

the failsafe map is selected and set as a threshold

changing pattern for activation of the airbag apparatus 30.

That is, under a circumstance that one of the

25   satellite sensors 16, 18 has a failure, the map of a

smaller threshold SH is selected from the failsafe map and

the map based on the sensor that normally functions, and is

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set as a threshold changing pattern. Therefore, according

to the embodiment, if one of the satellite sensors 16, 18

has a failure, the Hi map is not selected as a threshold

changing pattern, but a map that allows the airbag

5   apparatus 30 to be properly activated is selected. Thus,

according to the embodiment, it is possible to set the

threshold changing pattern for activation of the airbag

apparatus 30 to a proper value even if one of the satellite

sensors 16, 18 has failed.

10   FIG. 6 is a flowchart illustrating a control routine

executed by the ECU 12 in this embodiment in order to

realize functions mentioned above. The routine illustrated

in FIG. 6 is a routine repeatedly executed at every elapse

of a predetermined time. When the routine illustrated in

15 FIG. 6 starts, the processing of step 100 is first

executed.

    In step 100, it is determined whether the maps

selected based on the output signals of the satellite

sensors 16, 18 are one and the same map. If it is

20 determined that the two maps are the same, the processing

of step 102 is subsequently executed. Conversely, if it is

determined that the two maps are not the same, the

processing of step 104 is subsequently executed.

    In step 102, a processing is executed in which after

25 it is determined in step 100 that the two maps are one and

the same map, the map is selected and set as a threshold

changing pattern for determining whether to activate the

18

airbag apparatus 30. If the processing of step 102 is executed, the threshold SH on the map is compared with a value determined from the relationship between the calculated value f(Gf) and the speed Vn from then on.

5 Based on the result of comparison, the deployment of the airbag 36 is controlled. After the processing of step 102 ends, the present execution of the routine is ended.

In step 104, it is determined whether with regard to one of the satellite sensors 16, 18, the failsafe map has

10 been selected due to a failure or the like of that sensor. If it is determined that the failsafe map has not been selected with regard to either one of the satellite sensors 16, 18, the processing of step 106 is subsequently executed. Conversely, if it is determined that the

15 failsafe map has been selected with regard to one of the satellite sensors 16, 18, the processing of step 108 is subsequently executed.

In step 106, a processing is executed in which, of the two maps based on the output signals of the satellite

20 sensors 16, 18, the map of a smaller threshold SH, that is, the map on the Lol map side, is selected as a threshold changing pattern. If the processing of step 106 is executed, the threshold changing pattern of the smaller threshold SH is compared with a value determined from the

25 relationship between the calculated value f(Gf) and the speed Vn from then on. After the processing of step 106 ends, the present execution of the routine is ended.

In step 108, it is determined whether, under the
circumstance that the failsafe map is selected with regard
to one of the satellite sensors 16, 18, the map based on
the output signal of the other one of the satellite sensors
5   16, 18 is the Hi map. Comparison between the failsafe map
and the Hi map shows that the map having a smaller
threshold SH is the failsafe map. Therefore, if the map
based on the output signal of the normally functioning one
of the satellite sensors 16, 18 is the Hi map, it is
10 . appropriate to select the failsafe map as a threshold
changing pattern for activation of the airbag apparatus 30.
. Therefore, if determination is thus made, the processing of
step 112 is subsequently executed.

    Conversely, if the map based on the output signal of
15 the normally functioning one of the satellite sensors 16,
18 is not the Hi map, that is, if the map is the Lo1 map,
the Lo2 map or the Lo3 map, it is appropriate to select the
Lo map as a threshold changing pattern for activation of
the airbag apparatus 30 since comparison of the two maps
20 tells that it is the Lo map that has a smaller threshold
SH. Therefore, if determination is thus made, the
processing of step 110 is subsequently executed.

    In step 110, a processing is executed in which the Lo
map based on the output signal of the normally functioning
25 one of the satellite sensors 16, 18 is selected and set as
a threshold changing pattern. If the processing of step
110 is executed, the threshold SH on the Lo map and a value

determined from the relationship between the calculated

value f(Gf) and the speed Vn are compared from then on.

After the processing of step 110 ends, the present

execution of the routine is ended.

5   In step 112, a processing is executed in which the

failsafe map is selected and set as a threshold changing

pattern. If the processing of step 112 is executed, the

threshold SH on the failsafe map and a value determined

from the calculated value f(Gf) and the speed Vn are

10   compared from then on. After the processing of step 112

ends, the present execution of the routine is ended.

According to the above-described process, if the map

selected as a threshold changing pattern based on the

output signal of the satellite sensor 16 and the map

15   selected as a threshold changing pattern based on the

output signal of the satellite sensor 18 are different from

each other, one of the two maps that has a smaller

threshold SH can be selected and set as a threshold

changing pattern. Therefore, according to the embodiment,

20   it is possible to avoid an event that the airbag apparatus

30 becomes less prone to be activated under a circumstance

that there is a great impact on one of right and left

portions of a forward portion of the vehicle body. Hence,

the embodiment makes it possible to properly make

25   determination for activation of the airbag apparatus 30.

Furthermore, according to the above-described

process, if under a circumstance that one of the satellite

sensors 16, 18 has a failure, the map selected as a
threshold changing pattern based on the normally
functioning sensor is a Lo map, the Lo map can be selected
and set as a threshold changing pattern. If under the
5   aforementioned circumstance, the map selected based on the
normally functioning map is the Hi map, the failsafe map
can be selected and set as a threshold changing pattern.

The failsafe map partially overlaps the Lo3 map as
mentioned above. That is, if one of the satellite sensors
10 16, 18 has a failure in the embodiment, the map of a
smaller threshold SH of the failsafe map and the map based
on the normally functioning sensor can be selected and set
as a threshold changing pattern.

Therefore, according to the embodiment, if one of the
15 satellite sensors 16, 18 has a failure, it is possible to
avoid an event that the airbag apparatus 30 becomes less
prone to be activated and also to avoid an event that the
airbag apparatus 30 becomes prone to be activated when not
necessary. Therefore, according to the embodiment, even if
20 one of the satellite sensors 16, 18 has a failure, the
threshold changing pattern for activation of the airbag
apparatus 30 can be set to a proper value. Hence, it is
possible to properly make determination for activating the
airbag apparatus 30.

25   In the foregoing embodiment, the two satellite
sensors 16, 18 are disposed in a forward portion of the
vehicle body. If the maps based on the output signals of

22

the two sensors are different from each other, the map of a

smaller threshold SH is selected as a threshold changing

pattern. In this manner, the determination for activating

the airbag apparatus 30 is property performed. However, it

5   is also possible to apply the embodiment to a construction

in which at least three satellite sensors are disposed, and

the map of the least threshold SH among the maps based on

the three sensors is selected as a threshold changing

pattern.

10   As mentioned above, even if the thresholds that can

be separately set based on the output signals of a

plurality of second sensors are different from one another,

it is possible to set a proper value of the threshold.

Furthermore, even if at least one of the second

15   sensors has a failure, it is possible to set the threshold

for activation of the airbag apparatus to a proper value.

Satellite sensors 16, 18 that output level signals

corresponding to an impact on a vehicle 10 are provided

right and left portions of a forward portion of the vehicle

20   10, separately from a floor sensor 14. If a map Lo1, Lo2,

Lo3, Hi selected as a threshold changing pattern from an

impact (deceleration) detected based on the output signal

of one of the satellite sensors 16, 18 and a map Lo1, Lo2,

Lo3, Hi selected as a threshold changing pattern from an

25   impact (deceleration) detected based on the output signal

of the other satellite sensor are different from each

other, the map of a smaller threshold is selected from the

maps based on the output signals of the two satellite

sensors 16, 18, and is set as a threshold changing pattern

for determining whether to activate an airbag apparatus 30.

 While the invention has been described with reference

5 to preferred embodiments thereof, it is to be understood

that the invention is not limited to the preferred

embodiments or constructions. To the contrary, the

invention is intended to cover various modifications and

equivalent arrangements. In addition, while the various

10 elements of the preferred embodiments are shown in various

combinations and configurations, which are exemplary, other

combinations and configurations, including more, less or

only a single element, are also within the spirit and scope

of the invention.

CLAIMS:

1. An airbag apparatus activation control apparatus
comprising a first sensor (14) that is disposed at a
predetermined position in a vehicle and that outputs a
5   signal corresponding to an impact that occurs on the
vehicle (10), and activation control means (12) for
activating an airbag apparatus (30) if a parameter value
(f(Gf)) based on the signal outputted by the first sensor
(14) exceeds a predetermined threshold (SH),
10   a plurality of second sensors (16, 18) each of which
is disposed at a position in the vehicle (10) that is
different from a position of the first sensor (14) and each
of which outputs a signal corresponding to an impact that
occurs on a site in the vehicle related to the sensor (16,
15   18);
           the airbag apparatus activation control apparatus
being **characterized by** further comprising:
           threshold changing means (12) for changing the
predetermined threshold (SH) in accordance with signals
20   outputted by the plurality of said second sensors (16, 18)
on the basis of a threshold reduction map.

2. An airbag apparatus activation control apparatus
according to claim 1,
25   **characterized in that**
said threshold changing means (12) changes the
predetermined threshold (SH) in accordance with a signal

25

that indicates a greatest impact among signals outputted by
the plurality of said second sensors (16, 18).

3. An airbag apparatus activation control apparatus
5   according to claim 1,
characterized in that
if at least one of the plurality of second sensors (16, 18)
has a failure, said threshold changing means (12) changes
the predetermined threshold (SH) in accordance with the
10 signal outputted by at least one second sensor that does
not have a failure.

4. An airbag apparatus activation control apparatus
according to one of the preceding claims, **characterized in**
15 **that** the threshold changing means (12) sets a failsafe
predetermined value, if at least one of the plurality of
second sensors (16, 18) has a failure, and sets the
predetermined threshold (SH) to the failsafe predetermined
value when the predetermined threshold (SH) based on the
20 signal from the at least one second sensor that does not
have a failure is greater than the failsafe predetermined
value.

5. An airbag apparatus activation control apparatus
25 according to any one of claims 1 through 4, **characterized**
in that a value outputted by the second sensors (16, 18) is
a deceleration of the vehicle (10) or a value obtained by

integrating the deceleration with respect to a unit time.

6. An airbag apparatus activation control apparatus
according to any one of claims 1 through 5, **characterized**
5   **in that** the plurality of second sensors (16, 18) are
disposed forward of the first sensor (14) within the
vehicle (10).

7. An airbag apparatus activation control method for
10 activating an airbag apparatus (30) if a parameter value
(f(Gf)) based on a signal corresponding to an impact that
occurs on a vehicle (10) exceeds a predetermined threshold
(SH), **characterized by** comprising:
        setting a threshold (SH);
15   detecting an impact that occurs on the vehicle (10)
via a first sensor (14), and setting a parameter value
(f(Gf)) based on a signal outputted by the first sensor
(14) in accordance with the impact;
        detecting an impact that occurs on the vehicle (10)
20 via a plurality of second sensors (16, 18) that are
disposed at positions in the vehicle (10) different from a
position of the first sensor (14), and changing the
predetermined threshold (SH) in accordance with signals
outputted by the plurality of said second sensors (16, 18)
25 on the basis of a threshold reduction map; and
        activating the airbag apparatus (30) if the parameter
value (f(Gf)) exceeds the threshold (SH).

8. An airbag apparatus activation control method for
activating an airbag apparatus (30) according to claim 7,
characterized in that said threshold (SH) is changed in
5   accordance with a signal that indicates a greatest impact
among signals outputted by the second sensors.

9. An airbag apparatus activation control method for
activating an airbag apparatus (30) according claim 7 and
10   8, **characterized in that** if at least one of the plurality
of second sensors (16, 18) has a failure, said threshold
(SH) is changed in accordance with a signal outputted by a
second sensor that does not have a failure.

15   10. An airbag apparatus activation control method according
to claim 7 to 9, **characterized in that** if at least one of
the plurality of second sensors (16, 18) has a failure, a
failsafe predetermined value is set and the predetermined
threshold (SH) is set to the failsafe predetermined value
20   when the predetermined threshold (SH) based on the signal
from the at least one second sensor that does not have a
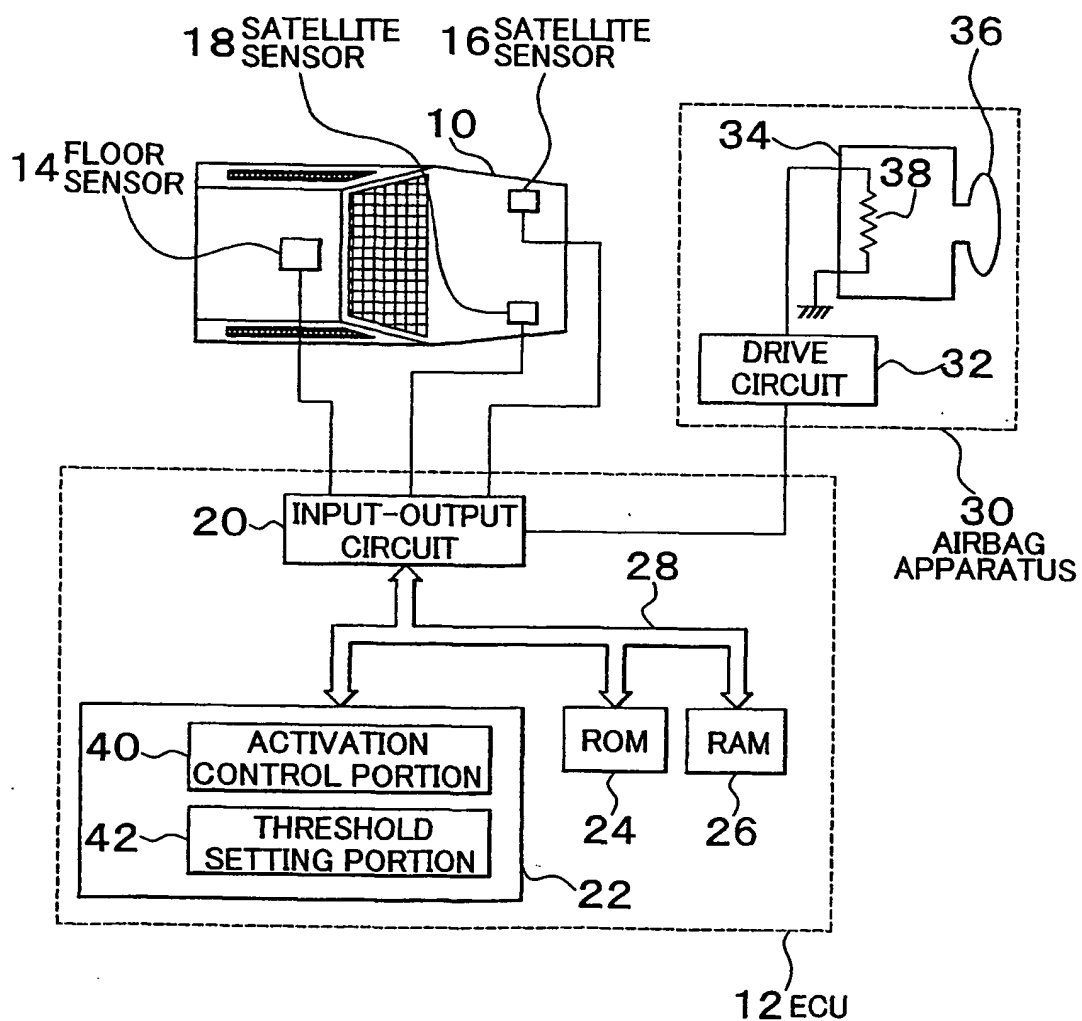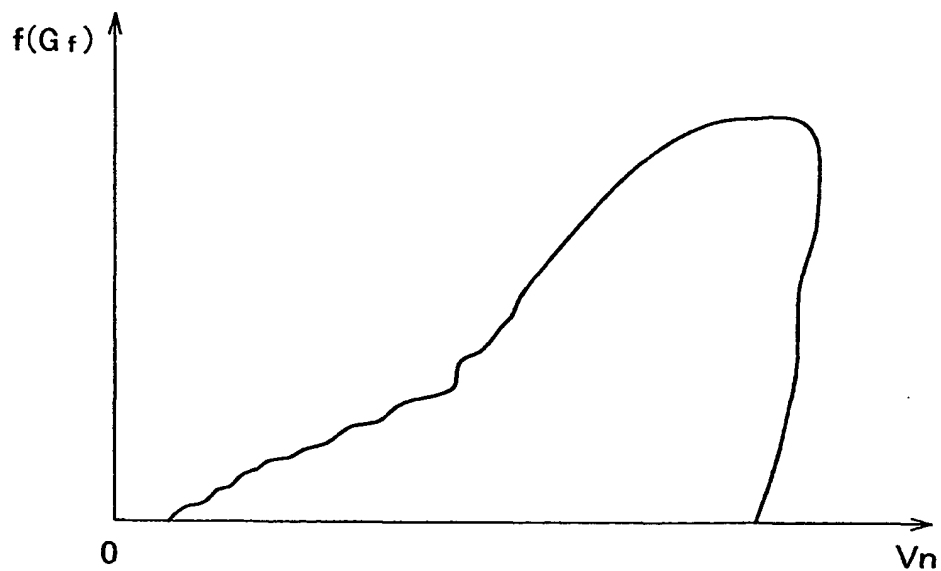failure is greater than the failsafe predetermined value.

F I G. 1

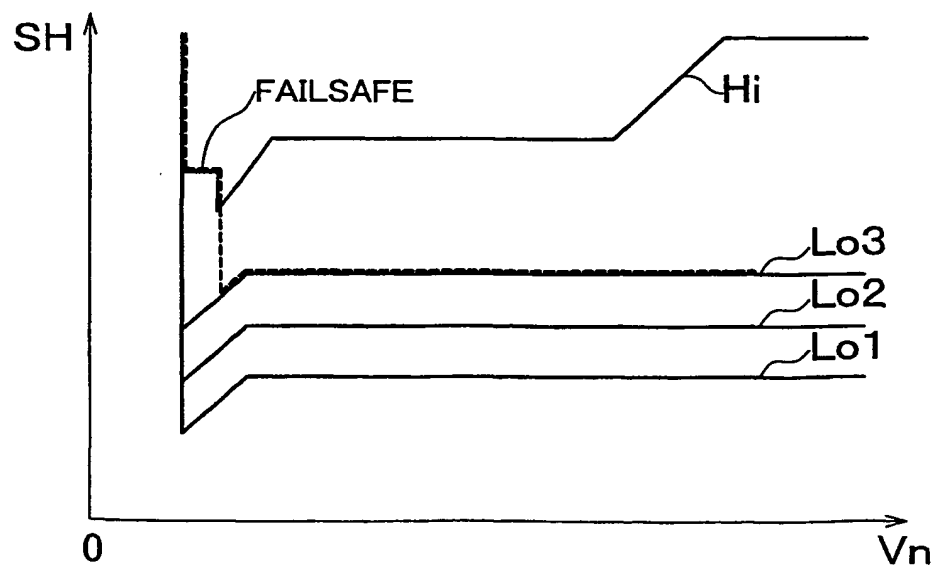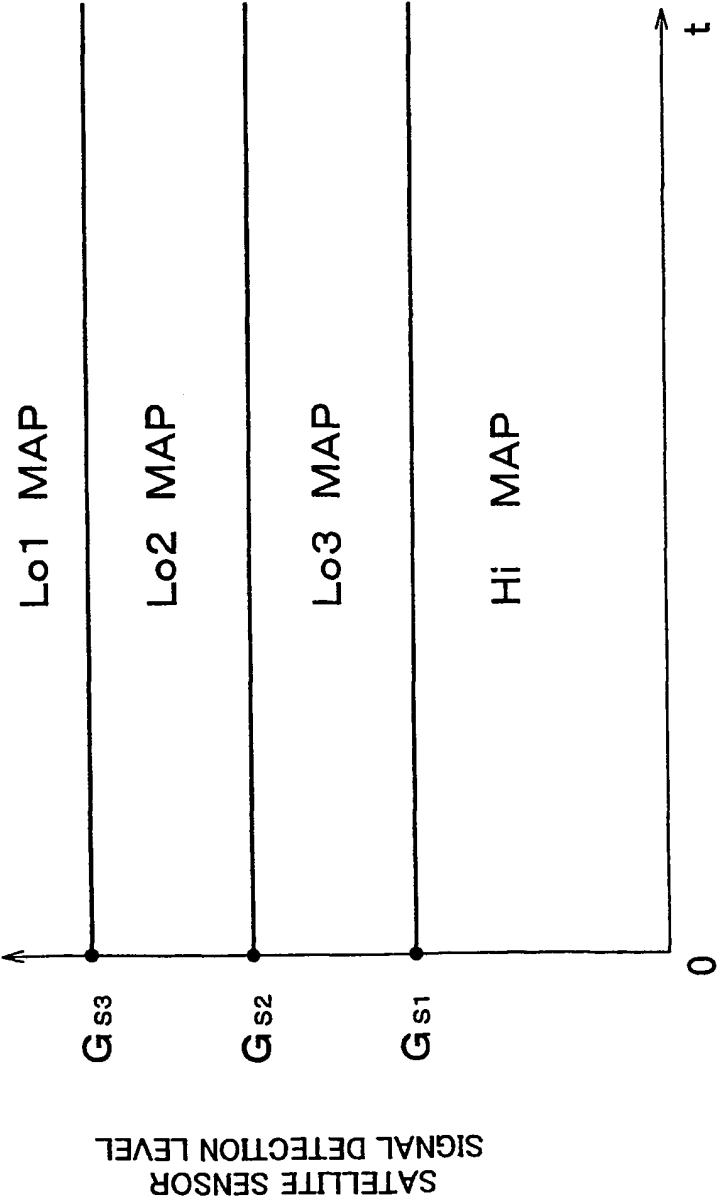18 SATELLITE SENSOR   16 SATELLITE SENSOR

36

10

34

38

14 FLOOR SENSOR

DRIVE CIRCUIT   32

30 AIRBAG APPARATUS

20 INPUT-OUTPUT CIRCUIT

28

ROM   RAM

40 ACTIVATION CONTROL PORTION

42 THRESHOLD SETTING PORTION

24   26

22

12 ECU

F I G. 2

F I G. 3

FIG. 4

SATELLITE SENSOR
SIGNAL DETECTION LEVEL

G s3 ── Lo1 MAP

G s2 ── Lo2 MAP

Lo3 MAP

G s1 ── Hi MAP

0 ──────────── t

FIG. 5

	RIGHT SATELLITE SENSOR				
LEFT SATELLITE SENSOR	**Hi**	**Lo3**	**Lo2**	**Lo1**	**FAILSAFE**
Hi	Hi	Lo3	Lo2	Lo1	FAILSAFE
Lo3	Lo3	Lo3	Lo2	Lo1	Lo3
Lo2	Lo2	Lo2	Lo2	Lo1	Lo2
Lo1	Lo1	Lo1	Lo1	Lo1	Lo1
FAILSAFE	FAILSAFE	Lo3	Lo2	Lo1	FAILSAFE

FIG. 6

START

100 SAME MAP SELECTED BASED ON TWO SATELLITE SENSORS ?
— YES → 102 THRESHOLD CHANGING PATTERN ← MATCHING MAP

— NO →

104 FAILSAFE MAP REQUEST PRESENT ?
— YES → 108 Hi MAP REQUEST PRESENT ?
  — YES → 112 THRESHOLD CHANGING PATTERN ← FAILSAFE MAP
  — NO → 110 THRESHOLD CHANGING PATTERN ← Lo MAP BASED ON OTHER SATELLITE SENSOR

— NO → 106 THRESHOLD CHANGING PATTERN ← SMALLER-THRESHOLD SH MAP OF MAPS BASED ON TWO SATELLITE SENSORS

END

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   B60R21/01

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 028 039 A (TOYOTA MOTOR CO LTD) 16 August 2000 (2000-08-16)	1,5-7
Y	page 6, line 29 -page 8, line 56 page 10, line 10 - line 52 figures 1,2,5,16,18,22,29	2,3,8,9
Y	US 5 461 566 A (MUSSER KEVIN E) 24 October 1995 (1995-10-24) column 3 -column 4 figures 1,2	2,3,8,9
A	WO 97 48582 A (AUTOMOTIVE SYSTEMS LAB) 24 December 1997 (1997-12-24) page 13, line 3 -page 15, line 17 page 17, line 10 -page 20, line 22 figures 1-7,9	1-10

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☒ Further documents are listed in the continuation of box C.   ☒ Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 December 2001	13/12/2001

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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